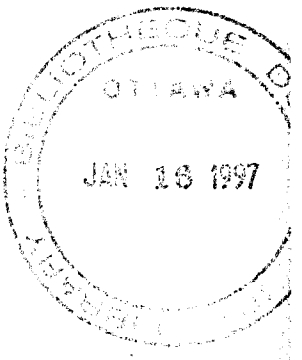
ALLOCATION OF WATER RESOURCES IN AFRICA: POTENTIAL FOR MOVING WATER IN AND OUT OF AGRICULTURE



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Introduction

Africa has the highest growth rate in the developing world, and food production is not keeping pace with population growth (Winrock 1993). Some of the most limiting factors to improved food production on the continent are the quality and quantity of available water resources.

Because food security is so closely linked to water availability and irrigation in many regions, conflicts over water are evident. Increasing water scarcity will increase the potential for conflict within and between nations. Water security is further jeopardized by pollution from human and industrial activities. The fact that less than 1% of the Earth's aquatic endowment is freshwater that is reliably available for human consumption calls for greater management and conservation (Carruthers and Morrison 1994; FAO 1993a, b).

This report will focus on water-allocation problems in Africa. A comparative analysis of North Africa and sub-Saharan Africa will highlight water needs for the agricultural, municipal, and industrial sectors; water sources and irrigation schemes, as well as their potentials for increasing food productivity; the consequences of shifting water resources from the agricultural sector; and ways to increase water availability.

Irrigation

Irrigation has played an enormous role in increasing agricultural output worldwide. Because of increasing population, demand for water for the agricultural, industrial, and domestic sectors has grown significantly. Consequently, water allocation has undergone a significant shift since the turn of the century, when almost 90% of water resources were consumed by agriculture. Recent figures indicate that irrigation worldwide now accounts for 62%, whereas industrial and municipal

consumption have increased from 6 to 25% and from 2 to 9% of allocation, respectively (FAO 1993a, b).

As the world population and competition for land increase, agricultural production on irrigated land will become more important. Today, an estimated 55% of global output of rice and wheat are from irrigated areas, and one third of the world's food is grown on 237 × 10^6 ha, or 17% of the irrigated arable land (Carruthers and Morrison 1994; FAO 1993a, b). Growth projections suggest that by 2025, 80% of global food production will come from irrigated land (FAO 1993a, b).

The population of sub-Saharan Africa is almost four times that of North Africa and is increasing at a faster pace (Table 1). The urban population is increasing much faster than the rural population.

Table 1. Demographic statistics for North and sub-Saharan Africa.

	North Africa	Sub-Saharan Africa
Population (million)	120	460
Growth (%)		
Rural	0.9	1.9
Urban	3.7	5.6

Source: FAO (1986a).

Sub-Saharan Africa lags far behind the rest of the world in proportion of irrigated arable land and its contribution to the total food supply. Of all the developing regions, water availability per capita is lowest in Africa. In North Africa, 11% of the land is irrigated (excluding Egypt's 100%), whereas in sub-Saharan Africa, it is only 3.5% of total cropped land (FAO 1986a, b, c). In North Africa, 3.4 × 10^6 ha is irrigated by large-scale systems, whereas in sub-Saharan Africa, half of the 5.3 × 10^6 ha is irrigated by large- and medium-scale systems; the other half, by small-scale systems. In terms of value, irrigation is responsible for an estimated 33 and 9% of the crops produced in North Africa and sub-Saharan Africa, respectively (Yudelman 1994).

Cereal production accounts for more than half the irrigated land in Africa, but in North Africa only 19% of the total cereal production is irrigated; in sub-Saharan Africa, a mere 2.5% (FAO 1986 a, b). The higher percentage in North Africa is due to Egypt's overwhelming contribution: cereal production covers 72% of Egypt's irrigated area. If the continent is to become self-sufficient in food production, land under irrigation will have to be increased.

Problems associated with irrigation include low groundwater potential, low aquifer-recharge rates, water-quality deterioration, and poorly drained, inefficient systems causing waterlogging and salinization. The latter two problems are the major causes of declining crop yields on irrigated lands in the arid and semi-arid regions (FAO 1986b). In many regions of North Africa, groundwater sources are being severely overexploited, and freshwater aquifers are deteriorating because of seawater intrusion (FAO 1993a, b). Thus, there is an immediate need to formulate and implement sustainable water-management strategies in this part of Africa.

Emerging scenario

Although the potential for expanding irrigation exists, agriculture will have to compete with the rapidly increasing urban sector, where municipal and industrial needs for water have dramatically escalated over the last two decades. In 1992, 88% of allocated water in Africa was for irrigation; 7%, for municipal use; and 5%, for industrial uses. Such a distribution among sectors is typical of low-income countries, where priority is given to agriculture because of the high multiplier effect a prospering agricultural sector can have on a developing economy. What is interesting to note, however, is that although high-income countries allocate a much smaller percentage of water to agriculture than do low-income countries, the total volume allocated to agriculture is still significantly greater because annual withdrawals per capita in richer countries are more than three times the volume consumed by low-income countries (Table 2).

Table 2. Sectoral water withdrawals by income group.

Country income group	Per capita annual withdrawal (m^3)	Per capita annual withdrawal (m^3)		
		Agriculture	Domestic	Industry
Low income	385	351 (91)	15 (4)	19 (5)
Middle income	454	313 (69)	59 (13)	82 (18)
High income	1 167	455 (39)	163 (14)	549 (47)

Source: World Bank (1992).
Note: Percentages in parentheses.

With urban populations continuing to grow, the allocation of water will have to change. The problem, however, is that if agricultural allocations are reduced and partially shifted to more lucrative urban markets, the rate of food

production, which presently is not keeping up with population growth, may be further undermined. Can both objectives be met? Most believe they can. How they are met, however, is a controversial issue. The conservationists believe that by increasing water-use efficiencies of current irrigation systems, some of which are estimated to waste 60% or more of diverted or pumped water, enough water can be saved to meet urban needs without compromising food production. Although proponents of new developments believe that conservation is a critical issue, many feel that eventually the need for new sources will arise.

Management strategies

Our biological, environmental, cultural, and socioeconomic relationships with water distinguish it from most other natural resources. This unique status poses a formidable challenge to water-management authorities because policies must take into account legal, social, environmental, technological, economic, and political considerations (FAO 1993a, b). Water is less expensive than other resources, such as oil; consequently, policymakers worldwide have tended to emphasize supply management.

However, the idea of increasing the supply of water commensurably with rising demand from the agricultural, municipal, and industrial sectors has recently fallen into disfavour because of escalating construction costs, substantially lower cereal prices, a growing environmental and social awareness, and inefficient irrigation (FAO 1993a, b). Costs associated with new large-scale irrigation systems in Africa have dramatically increased and now range between 10 000 and 20 000 United States dollars (USD) per hectare, whereas medium-sized systems are estimated at 7 200 USD per hectare (FAO 1993a, b). With such exorbitant costs, even double-cropping of high-value products cannot be made profitable. The economic costs are high because of reliance on foreign experts, equipment, and supplies for construction. This, in turn, is associated with the lack or demise of an indigenous irrigation culture in much of sub-Saharan Africa. Furthermore, social analyses of the impact of large-scale schemes have revealed both official corruption and negative impacts on women and other less powerful social groups. Because of these socioeconomic complexities, water-management officials are now faced with reduced venture and public capital for water initiatives, curtailed irrigation subsidies, greater cost-recovery emphasis, and mandatory efficiency intensification (FAO 1993a, b).

The concept of increasing the price of water, as a policy instrument to alter water-consumption behaviour, is receiving greater attention. Using pricing policies

in an effort to control water use may have far reaching implications that are intersectoral (agricultural versus industry), intrasectoral (rice versus maize), distributional (access and equity), and environmental (agricultural inputs and water quality) (FAO, 1993a, b). Determining where water is best used and its potential productivity is greatest is highly complex. Carruthers and Clark (1983) provided a classic illustration: although some 15 000 m^3 of water is required to irrigate 1 ha of rice, this same volume could just as well supply "100 nomads and 450 head of cattle for 3 years; or 100 rural families for 4 years; or 100 urban families for 2 years; or 100 luxury hotel guests for 55 days." The evaluation of these alternative uses remains somewhat subjective.

Although the price-control argument may have a sound economic basis, many arid and semi-arid countries remain reluctant to endorse it because water is so essential for life itself that it is not treated as a commodity. Cultural factors often play a pivotal role in water-allocation decisions, particularly where crop irrigation is essential to food security. In addition, increasing the cost of water may skew water distribution within society to the extent that only financially secure recipients could afford it. Such a scenario is often politically unacceptable because it is imperative that such a vital resource be equitably shared in society.

All of society relies on water for survival. As aggregate demand for water continues to soar, conflicts among user groups are bound to emerge. What are the consequences of shifting water allocation from agriculture to other sectors? Raising the cost of water may significantly increase the cost of irrigated produce, which in turn could affect a nation's competitiveness within a global economy. On a more regional scale, increased costs for water could be passed on to urban consumers via higher prices for irrigated goods. On the other hand, if growers are forced to absorb the increased cost of irrigated production, the tendency to shift to higher value crops is likely inevitable. What would the impact of such a shift in production be on, say, foreign currency earnings or the availability of traditional or local foodstuffs?

From the above statistics, it becomes obvious that although cereals account for a significant portion of irrigated land in Africa as a whole, only a very small fraction of total cereals in Africa is irrigated (19% in North Africa and 2.5% in sub-Saharan Africa). Consequently, there is an enormous potential to increase food productivity. The question is how? Strategies to tap this potential differ between North Africa and sub-Saharan Africa. In the latter, the irrigated area could be expanded by 330%. Although there is potential to expand irrigation in North Africa by an estimated 22% (Table 3), water sources are already overtaxed.

Table 3. Agricultural statistics for North and sub-Saharan Africa.

	North Africa	Sub-Saharan Africa
Food productivity, 1986 (%)		2.3
Cereal productivity, 1986 (%)		1.8
Irrigated cereals, 1986 (%)	19	2.5
Irrigated arable land, 1990 ($\times 10^6$ ha)	7.6	5.0
Irrigated arable land, 1986 (%)	11	3.5
Potential increase in irrigated arable land, 2025 ($\times 10^6$ ha)	1.6	16.5
Potential increase in irrigated arable land, 2025 (%)	22	330

Sources: FAO (1986a, b); IIMI (1994); and WRI, UNEP, and UNDP (1992).

North Africa

Irrigation systems in North Africa are generally inefficient and lack adequate drainage, resulting in severe waterlogging and salinization. Focus in North Africa should, therefore, centre on demand management, with conservation and increased water-use efficiency as the major policy objectives. The approach of repairing degraded systems and implementing stringent and effective conservation measures is gaining increased acceptance within the international community. This approach may be particularly appropriate in regions of North Africa that are under low and intermediate water stresses. Along with existing water supplies, estimated savings may then be reallocated to specific needs in other sectors. In the low- to medium-income countries, where 80% of available water is allocated to agriculture, it is estimated that a 10% increase in efficiency could translate into 50% more water for urban requirements (Yudelman 1994). Needless to say, such a strategy would also be less costly than new infrastructures, and society would benefit much sooner. The fact that present system efficiency can be improved at the local level is not disputed. However, some argue that at the watershed scale (the Nile River basin, for instance) little or no saving may accrue. Moore and Seckler (1993) commented that although increasing efficiency is commendable, additional water sources will inevitably have to be tapped.

Sub-Saharan Africa

In humid and sub-humid parts of the sub-continent, where climatic conditions are more favourable and water resources more abundant (FAO 1986a, c), the possibilities for increased irrigation are greater. In fact, 85% of sub-Sahara

Africa's irrigation potential remains untapped (FAO 1986a, c). The International Irrigation Management Institute estimates that irrigated land could be tripled. In those zones where rainfall is more evenly distributed, small-scale, community-based irrigation systems offer the greatest potential for significantly improving crop production. Supply-management strategies may be useful in sub-Saharan Africa, too, and improved water-use efficiency should not be ignored.

If a substantial increase in irrigated area is to be achieved on the continent, several limitations must be overcome. Traditional irrigation that has thrived in the past, notably in Zaire and Zimbabwe, should be revived. Large-scale irrigation systems are relatively recent. Before the middle of the 20th century, most water needs were met by capturing water from reliable and relatively inexpensive sources (FAO 1993a, b). A list of some of the advantages and disadvantages of large- and small-scale irrigation systems is provided in Table 4.

In sub-Saharan Africa, the most irrigated countries are Sudan (1.75×10^6 ha), Madagascar (960 000 ha), and Nigeria (850 000 ha) (FAO 1986b). Because most (65%) of the modern irrigation in the region is concentrated in Sudan, many of the remaining irrigation systems are traditional systems, operating much below their technical potential and efficiency. Improving the efficiency of traditional, small-scale systems calls for maximization of available rainfall and soil-management strategies that build water-holding capacities, promote greater water infiltration and percolation, reduce runoff, and decrease evaporation (mulching and conservation tillage).

Madagascar is one of the leading countries in sub-Saharan Africa in achieving irrigation potential (Yudelman 1994). Many of the systems in Madagascar have Asian farming components, and such systems may be relevant to, and beneficial for, other regions. If a small-scale traditional irrigation culture is to be reborn, Madagascar is the logical partner to share the knowledge it has acquired via community-based, farmer-to-farmer, technology-transfer mechanisms. Based on experiences from large-scale irrigation interventions in West Africa, such an approach may be more appropriate and yield better results.

Conclusion

In sub-Saharan Africa, the main challenge is to capture more of the available water resources. The main recommendations for the region are the following:

1. Look for ways to effectively build on local knowledge, institutions, and solutions for better water management. Revitalize indigenous systems and transfer experiences from Madagascar. All of these are promising avenues to be explored.

Table 4. Advantages and disadvantages of large- and small-scale irrigation systems.

Large-scale systems	Small-scale systems
Socioeconomic effects	
Regional economic growth	Increased local employment
Power generation	
Flood control	
Tourism	
Transport	
New = 10 000 – 20 000 USD/ha	New = 500 – 1500 USD/ha
Repair = 1 500 – 2 000 USD/ha	Little or no irrigation fees
Resettlement of inhabitants	Little or no resettlement
Increased cropping index	Protection from seasonal drought
Physical effects	
High level of water control	Low level of water control
High water-storage capacity	Low water-storage capacity
High water losses (≥60%)	Low water losses
Low efficiency	High efficiency
Environmental effects	
Fishing in reservoir	Less incidence of disease
Creation of wildlife sanctuaries	
Rerouting of watercourses	
Destruction of native habitat	Preservation of native habitat
Losses of forest and agricultural land in reservoir	Insignificant land losses
Increased waterlogging and salinization from high water table and no drainage	Increased waterlogging and salinization from high seepage in earthen canals
Degradation of riparian zone	
Increased flooding and downstream sedimentation	
Changes in water chemistry	
Eutrophication	
Barrier to fish migration	
Problems associated with changes in temperature	

2. Avoid large-scale irrigation schemes. The experience with such projects in the Sudan and in West Africa offers many lessons. There is now abundant literature describing the plethora of problems that have resulted from these donor-driven engineering solutions to water scarcity in the Sahel.

This is not to say that large-scale infrastructures may not be necessary or desirable under some circumstances, but rather that their necessity should not be assumed. When these infrastructures are deemed desirable by the majority of the potential users, particular care needs to be taken with the politics of implementation and management.

In North Africa, in contrast, most irrigation potential has already been tapped. Conflicts between urban and agricultural uses, as well as interstate conflicts concerning large river systems such as the Nile, are becoming severe. The main recommendations are the following:

1. Find alternative social and technical approaches to increase conservation and water-use efficiency in urban and agricultural settings.

2. Create effective and representative national and international institutions for negotiating water rights and resolving conflicts.

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WATER MANAGEMENT *in* AFRICA *and the* MIDDLE EAST

CHALLENGES *and* OPPORTUNITIES

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